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Return Hospital Admissions Among 1419 Covid-19 Patients Discharged from Five US Emergency Departments

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Author Contributions

ASK, KL, ZFM, DAA, and MKD conceived and designed the study. NM provided statistical advice on the study design. ASK and MKD supervised the conduct of the study, including data collection and analysis. CKS collected and prepared data used for analysis in the study. ASK, CKS, NM and MKD performed statistical analysis. ASK drafted the manuscript,

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Although many ED patients with known or suspected Covid-19 require hospital admission, the majority are discharged home.[1] Concern for surges in hospital occupancy compel emergency providers to preserve inpatient resources and discern which patients benefit most from admission.[2] Even in the absence of surge conditions, patients may prefer to recover at home if safe to do so.[3] However, some patients with Covid-19 experience delayed decompensation.[4] Patients may develop serious illness several days after initial symptoms and require respiratory support.[5] Additional complications, including venous thromboembolism, myocarditis, and acute kidney injury, may also require advanced therapies.[6] It is not known how often and which patients with Covid-19 return to the hospital following initial evaluation in the ED. To date, prediction models have focused on the risk of critical illness among hospitalized patients.[1,5] In this study, we describe the incidence of return hospital admission within 72 hours for patients with Covid-19 who were discharged from the ED upon initial presentation. We also evaluate patient characteristics associated with return hospital admission.

We conducted a retrospective cohort study of adult patients with Covid-19 discharged from five distinct hospital EDs within a multi-hospital health system spanning Pennsylvania and New Jersey. Using electronic health record data, we identified all ED encounters from March 1 to May 28, 2020 for patients whose Covid-19 infection was confirmed by diagnostic testing. Patients were included in the study cohort if they tested positive for Covid-19 within 7 days before or after the ED encounter, an extension of the case definition employed by the Centers for Disease Control and Prevention.[7] Testing was performed either internally within

the health system or externally with documentation of the test date. Patients were excluded if no vital signs were recorded during the ED encounter or if they were younger than age 18. The initial ED encounter is defined as the *index ED encounter*. For patients with multiple qualifying encounters during the study period, only the first was included.

The binary primary outcome was inpatient admission or observation within 72 hours of the index ED encounter, defined as *return hospital admission*. Prior studies and quality metrics use this time period to examine return visits. Although ED encounters were limited to hospitals within the health system, data available through a regional health information exchange (HIE) allowed us to identify return admissions at unaffiliated hospitals in the region. We determined outcomes using electronic health record data or from the HIE. In addition to the primary outcome, we assessed whether patients had return hospital admissions at 7 days following discharge.

Selection of covariates occurred prior to analysis and was based on previous literature on risk factors for severe Covid-19 illness. While many patient characteristics, co-morbidities, and diagnostic tests have been evaluated as risk factors for severe Covid-19 infection, we sought to include risk factors relevant to patients being considered for ED discharge and ensure the robustness of the model by limiting the number of covariates. We chose not to include high-risk conditions or lab tests because they may only apply to admitted patients.[1,4] Covariates included patient age, sex, and race/ethnicity, as well as the presence or absence of hypertension, diabetes, and obesity (body mass index ≥ 30 kg/m^2).[5,6] We also included chest radiograph findings, based on the attending radiologist interpretation, in two categories: 1) normal or not performed, and 2) indeterminate or abnormal. Finally, we created binary covariates for the presence or absence of three abnormal vital signs upon presentation: fever (temperature > 38°C), hypoxia (pulse oximetry less than 95% on room air), and tachycardia (pulse rate > 100 beats per minute).

Descriptive statistics were used to summarize covariates and unadjusted outcomes. We performed diagnostic checks to examine influential data points; no outliers were excluded. For the adjusted analysis, we used a generalized estimating equations (GEE) approach to compare characteristics of patients with return hospital admissions and those without.[8] The GEE clustered patients by hospital site, using an independent working correlation structure, logit link function, and robust standard errors. We report adjusted odds ratios (AOR) and adjusted marginal probabilities, along with corresponding 95% confidence intervals (CI). Measures of the discriminative ability of the model and goodness-of-fit are presented in the Supplement. For all analyses, we consider $P < .05$ (2-sided test) to be statistically significant. Analyses were conducted using Stata, version 15.1 (StataCorp LLC). The ___ institutional review board approved this study.

The cohort included 1419 patients with an index ED encounter that resulted in discharge. A total of 66 patients (4.7%; 95%CI 3.6 to 5.7) had a return hospital admission within 72 hours **(Table)**. An additional 56 (3.9%) patients returned to an ED within 72 hours but were again discharged.

In the adjusted model, compared to patients aged 18-39, patients aged >60 (AOR 4.6; 95%CI 2.2 to 9.5) had significantly increased odds of return admission (**Table**). The adjusted probability of return admission for patients aged > 60 years was 9.0% (95%CI 5.5 – 12.5) as compared to 2.6% (95%CI 1.2 – 4.0) for patients aged 18-39 years.

Odds of return admission were significantly higher for patients presenting with hypoxia (AOR 2.9; 95%CI 1.2 to 7.2) compared to those with normal oxygenation. Patients presenting with fever also had higher odds of return admission (AOR 2.4; 95%CI 1.3 to 4.5) compared to those who were afebrile. Finally, patients with abnormal chest radiograph (AOR 2.4; 95%CI 1.5 to 3.7) had

higher odds of return admission compared to the group with chest radiographs that were normal or not performed.

A total of 117 (8.2%; 95%CI 6.8 to 9.6) returned to a hospital for admission within 7 days (**Supplement**). All statistically significant risk factors identified for the primary outcome remained significant. Three additional risk factors were associated with increased odds of return hospital admission within 7 days of the index ED encounter: hypertension (AOR 1.5; 95%CI 1.1 to 2.0), obesity (AOR 1.5; 95%CI 1.1 to 2.0), and age between 41-59 years (AOR 2.1; 95%CI 1.6 to 2.8).

To our knowledge, no prior study has evaluated the outcome of return hospital admission in patients with Covid-19 following ED discharge. This overall rate of return hospital admission is twice that reported for the general ED population prior to the pandemic, and elderly patients returned at a markedly higher rate.[9] Furthermore, some risk factors, including age > 60 years, fever on presentation, and hypoxia on presentation, were associated with more than twice the probability of subsequent return hospital admission.

While emergency clinicians are well-suited to manage patients who present to the hospital with severe illness, patients who appear relatively well represent a different challenge. Early reports indicated that patients with mild symptoms of Covid-19 might worsen days after the onset of symptoms, defying expectations for their prognosis.[4,10] The uncertain natural history of this illness may make it difficult for emergency providers to predict which patients will worsen among those who initially appear well.

Even with better evidence to guide disposition, it may not be feasible – or effective – to admit all patients with higher risk upon first presentation. Importantly, return hospital admission does not equate to failure in patient care. Rather, this outcome represents the need for a higher level of care than can be

provided at home. Patients may prefer to be discharged from their initial ED visit, despite the risks, with a plan for hospitalization if the need develops. Both physicians and patients can benefit from information on the risk for return hospitalization and receive anticipatory guidance for symptoms that should prompt return. Risk stratification may further improve the efficiency and effectiveness of home monitoring and telemedicine services by focusing attention on patients at higher risk for deterioration.[11]

This study has several limitations. First, the cohort included only patients presenting to the EDs within a single health system. Second, patients might travel for return hospital admissions outside the geographic range of the health information exchange. Third, we intentionally did not examine specific diagnoses for the index ED encounter or return hospital admission; some ED visits and return hospital admissions were unrelated to Covid-19 but rather occurred incidentally in patients infected with the novel coronavirus. Fourth, providers treating patients in this study were not necessarily aware of the Covid-19 status of patients. Fifth, we do not account for patients who may have died at home. Sixth, we did not include the full range of potential risk factors as covariates in the model that may be associated with return hospital admission. Finally, this study does not include patients with Covid-19 with false-negative tests.

In this study, we found that approximately 5 percent of patients with Covid-19 discharged from the ED returned for an unscheduled hospital admission within 72 hours. Age, abnormal chest x-ray findings, and fever or hypoxia on presentation were independently associated with increased rate of return admission. The Covid-19 pandemic has challenged emergency providers to deliver time-sensitive interventions under difficult circumstances. An additional challenge is posed by patients that appear well enough to be discharged upon initial presentation but may require subsequent admission. As the pandemic evolves, further investigation may be needed to develop risk stratification tools that guide disposition for patients with Covid-19 in the ED.

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Table. Return hospital admissions within 72 hours of discharge from an index ED encounter for patients with Covid-19 (N = 1419)

Patient Characteristics		All Patients (N = 1419) No. (%)	Return hospital admission within 72h of discharge from index ED encounter No. (%)		Adjusted Odds Ratio (95%CI)	*P*	Adjusted Probability % (95% CI)
			Yes (n = 66)	**No** (n = 1353)			
Age, years							
	18-39	635 (44.8)	13 (19.7)	622 (46.0)	reference	--	2.6 (1.2 – 4.0)
	40-59	534 (37.7)	26 (39.4)	508 (37.6)	2.0 (0.9 – 3.9)	.06	4.3 (2.7 – 5.9)
	≥ 60	250 (17.6)	27 (40.9)	223 (16.5)	4.6 (2.2 – 9.5)	< .001	9.0 (5.5 – 12.5)
Sex							
	Male	642 (45.2)	32 (48.5)	610 (45.1)	reference	--	4.7 (3.1 – 6.2)
	Female	777 (54.8)	34 (51.5)	743 (54.9)	1.0 (0.8 – 1.3)	.88	4.6 (3.2 – 6.0)
Race/Ethnicity							
	Non-Hispanic White	262 (18.5)	11 (16.7)	251 (18.6)	reference	--	4.1 (1.7 – 6.5)
	Non-Hispanic Black	777 (54.8)	37 (56.7)	740 (54.7)	1.1 (0.4 – 2.6)	.87	4.8 (3.2 – 6.4)
	Hispanic	258 (18.2)	12 (18.2)	246 (18.2)	1.5 (0.7 – 3.3)	.30	4.9 (2.1 – 7.7)
	Other / Unknown	122 (8.6)	6 (9.1)	116 (8.6)	1.0 (0.4 – 2.7)	.92	4.1 (0.9 – 7.3)
History of Hypertension							
	No	1127 (79.4)	44 (66.7)	1083 (80.0)	reference	--	4.3 (3.1 – 5.6)
	Yes	292 (20.6)	22 (33.3)	270 (20.0)	1.3 (0.8 – 1.9)	.28	5.5 (3.0 – 8.1)
History of Diabetes							
	No	1287 (90.7)	56 (84.9)	1231 (91.0)	reference	--	4.7 (3.5 – 5.8)
	Yes	132 (9.3)	10 (15.2)	122 (9.0)	0.9 (0.6 – 1.5)	.79	4.4 (1.4 – 7.4)
Obesity							
	Not obese	703 (49.5)	29 (43.9)	674 (49.8)	reference		4.2 (2.7 – 5.7)
	Obese	716 (50.5)	37 (56.1)	679 (50.2)	1.1 (0.6 – 2.3)	.72	5.0 (3.5 – 6.6)
Fever on arrival							
	No	1236 (87.1)	44 (66.7)	1192 (88.1)	reference	--	3.8 (2.8 – 4.9)
	Yes	183 (12.9)	22 (33.3)	161 (11.9)	2.4 (1.2 – 4.5)	.01	8.6 (5.0 – 12.1)
Tachycardia on arrival							

	No	933 (66.5)	33 (50.0)	900 (66.5)	reference	--	3.9 (2.6 – 5.1)
	Yes	486 (34.3)	33 (50.0)	453 (33.5)	1.7 (0.8 – 3.5)	.14	5.9 (3.9 – 7.8)
Hypoxia on arrival							
	No	1310 (92.3)	47 (71.2)	1263 (93.4)	reference	--	3.9 (2.9 – 5.0)
	Yes	109 (7.7)	19 (28.8)	90 (6.7)	2.9 (1.2 – 7.2)	.02	9.3 (5.1 – 13.5)
Chest Radiograph							
	Normal or not performed	1050 (74.0)	29 (43.9)	1021 (75.5)	reference	--	3.2 (2.0 – 4.3)